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TOOLS FOR INSPECTING AND SAMPLING WASTE IN UNDERGROUND RADIOACTIVE STORAGE TANKS WITH SMALL ACCESS RISER OPENINGS

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ABSTRACT

Underground storage tanks with 2” to 3” diameter access ports at the Department of Energy’s Savannah River Site have been used to store radioactive solvents and sludge. In order to close these tanks, the contents of the tanks need to first be quantified in terms of volume and chemical and radioactive characteristics. To provide information on the volume of waste contained within the tanks, a small remote inspection system was needed. This inspection system was designed to provide lighting and provide pan and tilt capabilities in an inexpensive package with zoom abilities and color video. This system also needed to be utilized inside of a plastic tent built over the access port to contain any contamination exiting from the port. This system had to be built to travel into the small port opening, through the riser pipe, into the tank evacuated space, and out of the riser pipe and access port with no possibility of being caught and blocking the access riser. Long thin plates were found in many access riser pipes that blocked the inspection system from penetrating into the tank interiors. Retrieval tools to clear the plates from the access riser pipes were developed and utilized. Finally, samples of the solvent and sludge were taken from the tanks using developed sampling devices while providing safe containment for the samples. This paper will discuss the inspection systems, tools for clearing access pipes, and solvent sampling tools developed to evaluate the tank contents of the underground solvent storage tanks.

1. BACKGROUND

1.1 Waste Tanks

The waste tanks of the burial grounds are long cylindrical buried tanks. There are 22 tanks which range from 18 to 35 feet in length with an inside diameter of 7 to 11 feet. The tanks can be accessed by two risers that are 2-3 inches in inside diameter. The access risers are positioned at opposite ends of the tanks and protrude from the ground surface above the tank. The tanks are made of carbon steel with the outer surface painted and the inner surface covered with a layer of corrosion. The access pipes for the different tanks range from 5 to 11 feet in length. The solvent tanks are not level and collect their waste contents on the low end.

1.2 Waste Material

The solvent tanks were filled to capacity from 1952 to 1972. The tanks received waste from the plutonium and uranium extraction process performed in the SRS Separations facilities. A result of this process was large amounts of solvents containing plutonium and uranium contaminants. The solvent was dissolved in kerosene to extract the contaminants, neutralized with caustic compounds, and stored in the tanks to allow solids to settle out and some radioactive decay to take place. Most of the waste was transferred from these tanks, but some solvent and residue were not pumpable and remain in the tanks. In several of the tanks, the solvent and residue exist as solvent and sludge. Other tanks have allowed drying to occur and contain a cracked, thin layer of dried sludge on the tanks lower inner wall. These tanks also contain gases that are produced by the decay of the waste.

1.3 Need for Inspection and Sampling

In order for the tanks to be closed, the tanks need to be inspected for the type of waste contained the location of the waste within the tank, and the volume of waste remaining. The type of waste, as determined by a visual inspection, will help to determine what type of sampler should be used in the tank to obtain the desired sample. The location of the waste in relation to the access riser opening also will determine which sampling device should be utilized. The visual inspection of the interior of the tank will also assist in providing an estimate of the waste volume in the tank.

Any significant amount of waste observed must be sampled. The remaining waste needs to be sampled to quantify the radioactive constituents in the tank. This obtained data along with the visual data on waste total volume in the tank allows an estimation of the total tank concentration of radioactive materials. The remaining waste characteristics will determine if the tank can be closed or requires further cleaning.

1.4 Available Inspection Technology

The inspection task required to provide useful imagery of the tank interiors requires an inspection device that can enter an access riser with a 2 to 3 inch inner diameter. Once inside the tank, the inspection system must provide enough light to allow videotaping of the entire length of the tank. The inspection system must also be able to remotely pan and tilt to allow full observation of the tank interior. The system must also be capable of being retrieved from the tank for further use and be inexpensive considering the eventual disposal of the system.

Many inspection systems are available commercially for remote use. These systems are typically borescope systems which were developed to inspect the inside of pipes or small passages inside the human body. Borescopes with articulating heads are available which provide some remote directing of the image. These borescope systems are relatively expensive and provide light only enough for viewing close to the lens. Other light/camera packages are available but are too large to enter the access riser of the solvent tanks.

1.5 Available Sampling Technology

The sampling task required to provide useful data on the tank contents must be obtained by accessing the tank risers with a two to three inch inner diameter. The sampling devices then must be able to transfer solvent or sludge out of the tank without leaking any of the waste sample. Leaking of the solvent outside of the access riser could cause loss of containment of the riser enclosure and exposure to operations personnel. The solvent must be transferred into a bottle and the sludge sample placed in a shielded transport package. The sampling devices also must not produce any sparking during use in case of an explosive atmosphere within the tank.

Many sampling devices are available commercially for taking core samples or for drawing liquid into a syringe. The commercial core samples are not sized to fit within the designated transport package and are not non-sparking. The syringe type samplers would require retrieval from the tank to empty into the sample bottle, raising the possibility of unnecessary contamination of the riser and riser-top.

2. REMOTE SPECIALIZED EQUIPMENT

2.1 Inspection Equipment

2.1.1. 3” Inspection System

An inspection system was developed with a color video camera, a zoom lens, and a high intensity light. The camera was mounted in a housing which enabled it to be tilted up and down remotely by safety cables once inside the tank. The system was also designed to be panned by rotating a steering plate on top of the riser. The light demanded a special deployment due to the narrow access riser along with the need for the light to be parallel to the camera. The light was mounted to a springed door in the side of the system housing and secured with an electromagnet. Once the inspection system penetrates the inside of the tank, the electromagnet is released, allowing the springed light panel to rotate out of the camera housing and into position. The light housing is closed during the retrieval of the inspection system up the access riser. The light housing closes when it comes in contact with the access riser on the inside of the tank. A 3” Inspection System was built and several tanks were found to have access pipes with an inner diameter of only 2”.

2.1.2. 2” Inspection System
A second inspection system in a smaller housing was developed with a video camera, a wide-angle lens, and a high intensity light. The wide-angle lens was fixed to provide focused views of the length of the tank and close to the camera. The fixed wide-angle lens eliminated the need for a zoom lens, which could not pass through the 2” diameter access riser.

Use of the inspection systems aided in the discovery of several blocked access risers. These access risers contained flat barstock made possibly of stainless steel with a cross section of approximately 1-1/4 inch by 1/4 inch and up to 11 feet in length. The top end of the barstock was several feet down in the riser. Multiple pieces of barstock were also found in the same riser. Inspection of the tanks with blocked risers could not continue without removal of the barstock.

2.2 Retrieval Equipment

A search was conducted of available retrieval devices. Magnetic retrieval devices were considered but would require the barstock to be magnetic in nature. Magnets would also have difficulty in traveling down the access riser which is also magnetic. Magnets are also weak in shear and only a minimal area for attaching the magnet for axial loading is available. Magnets also have poor mating of the magnet to surface when the surface is corroded or painted.

Suction retrieval systems were also considered but needed large surface areas for attachment to lift the weight of an 11 foot piece of barstock. A mechanized jaw was also tried and was not able to grip on the barstock in a mockup. Part retrievers were also considered but were deemed too weak to lift the barstock. Therefore, a retrieval tool was needed.

2.2.1 Slip Clamp Retrieval Device
Several tools were developed to be guided down the access riser, grip the barstock, and remove the barstock from the riser. One of these devices is the Slip Clamp. The slip clamp is a disposable device which uses a springed “alligator” type electrical clamp mounted on a guide to grip the barstock. The slip clamp was designed to slide down the access riser with the clamp open on the end of the guide. The barstock then slides into the guide and pushes the clamp free of the guide separating the jaws, allowing the clamp to grip onto the barstock.

2.2.2 Wedge Retrieval Device
The Wedge Retrieval Device is composed of a springloaded wedge in a guide housing. The guide housing helps to guide the barstock into the housing and past the springloaded wedge. Once the barstock hits the top of the housing, the housing is lifted out of the riser and the wedge drives into the barstock not allowing the barstock to leave the housing.

2.2.3. Wedge Wheel Retrieval Device
The Wedge Wheel Retrieval Device is composed of a wheel with sharp teeth that is mounted in a guide housing. The wedge wheel travels along a sloped path and uses the same principle of the Wedge Retrieval Device with the difference of the wheel rotation. The housing is lowered down the access riser until the barstock slides into the housing guide. The barstock then pushes past the wheel rotating it away from its direction of travel. The housing is then lifted out of the riser. The barstock attempts to slide out of the housing but the wheel rotates towards the barstock and the attempts to move down the sloped slot, pinning the barstock in place.

2.3 Sampling Equipment

2.3.1 Solvent Sampling

A pump containment assembly was developed which houses a peristaltic pump and sample bottle while providing containment for the liquid solvent. The enclosure assembly mounts inside of a glove bag on top of the tank riser. The enclosure contains a peristaltic pump that the operator uses to obtain a sample. The enclosure is designed to contain the waste solvent and prevent solvent contact with the glove bag which could compromise the glove bag containment.

The assembly provides simple changeout of the sample bottle and sampling hose and even allows the pump to be replaced with the use of several quick release pins. The enclosure does not allow any solvent to escape with the use of a translucent sliding cover which is in place when the pump is in use. The cover is raised and locked in place during bottle, hose, and pump replacements. The hose extending from the tank bottom, through the pump, and into the sample bottle is dropped back into the tank after its use in each tank.

2.3.2 Sludge Sampling

A Sludge Core Sampler was designed to obtain samples from directly below the riser. The sampler uses a nonsparking sample corer to eliminate possible ignition of any explosive compounds that might be present in the tanks. Multiple sizes of sample cups were constructed for use in dry sludge with a range of cohesiveness. The sampler cup is attached to numerous pipe extensions connected with quick disconnect couplings. The short extensions and couplings make assembly, containment, disassembly, handling and disposal of the sampler's deployment pipe operator friendly. The short extensions also reduce the size of the glove bag to be used on top of the riser by allowing the operator to connect and disconnect the extensions within the glove bag. A sludge sampling enclosure was also constructed for this device to ensure that the waste material samples obtained in the tank will not come in contact with the glove bag.

3. SUMMARY

The inspection systems were used successfully to quantify the types, locations, and quantity of waste remaining in the solvent tanks. The inspection devices identified the barstock blocking some of the risers. The retrieval devices were used successfully to remove the barstock from the risers. The barstock were found to be made of either aluminum or stainless steel. The solvent and sludge samplers were used successfully to obtain samples to aid in the closure of the solvent tanks.

4. ACKNOWLEDGEMENTS

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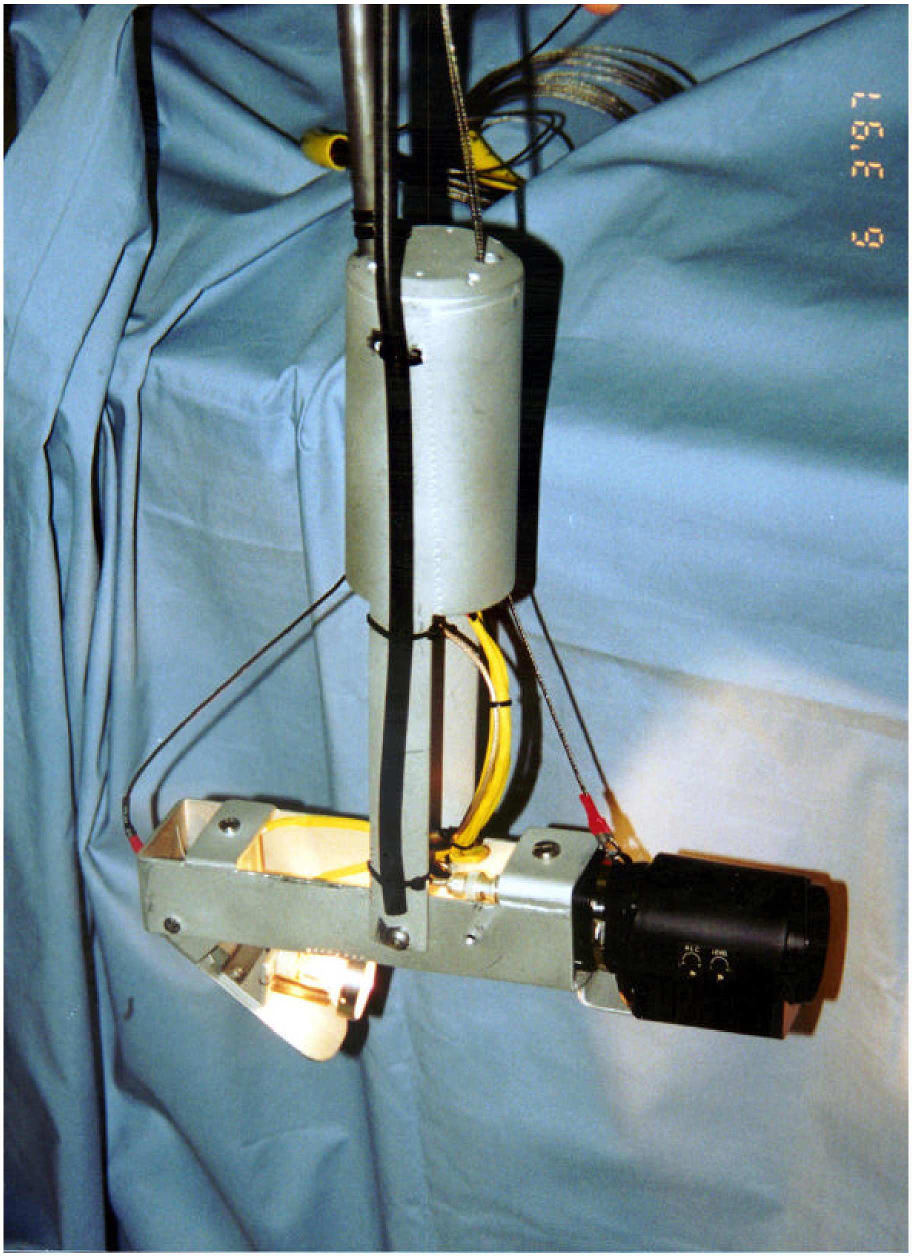

Figure 1: 3” Inspection System

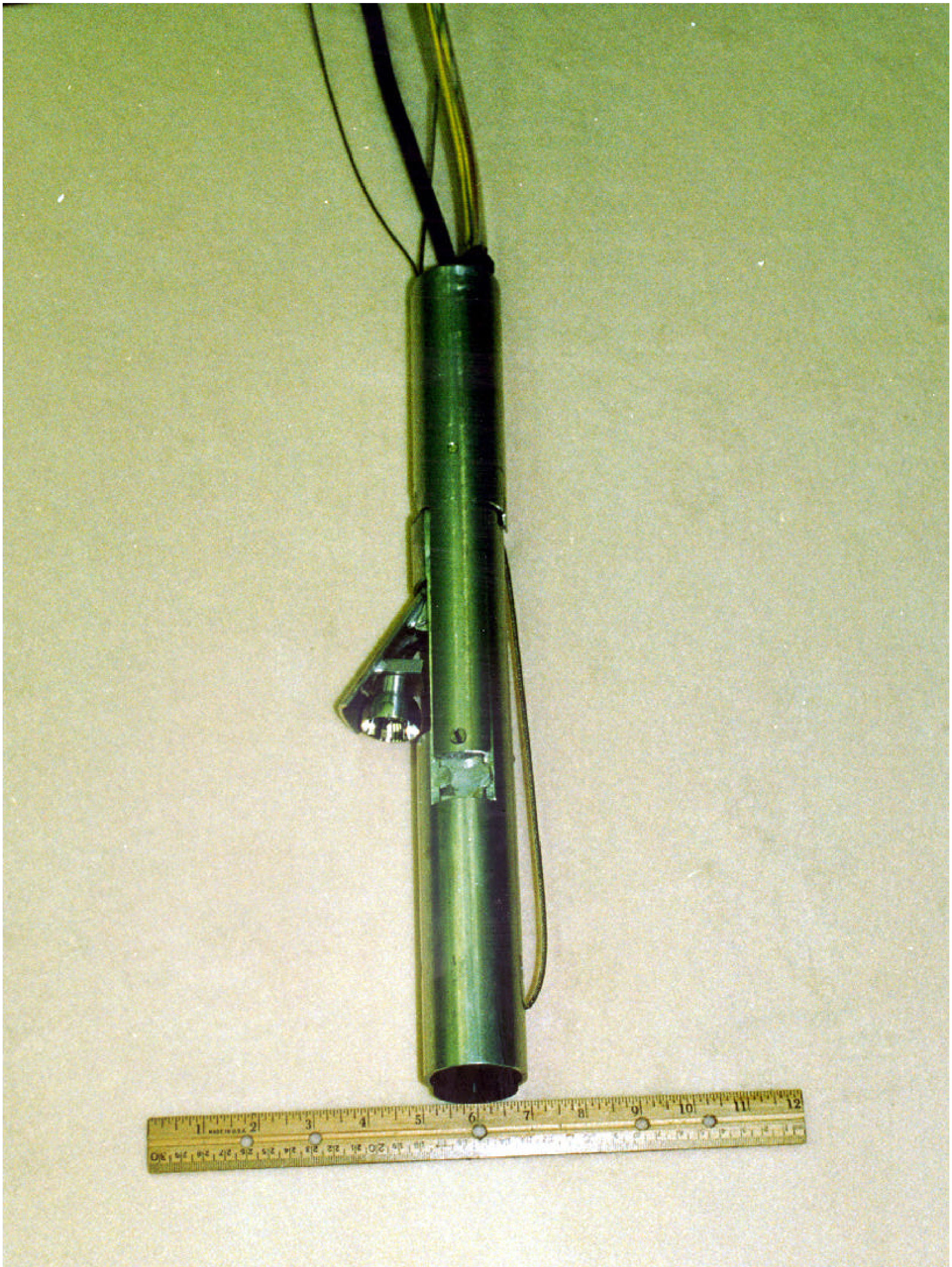

Figure 2: 2” Inspection System

Figure 3: Slip Clamp Retrieval Device

Figure 4: Slip Clamp Retrieval Device With Captured Item

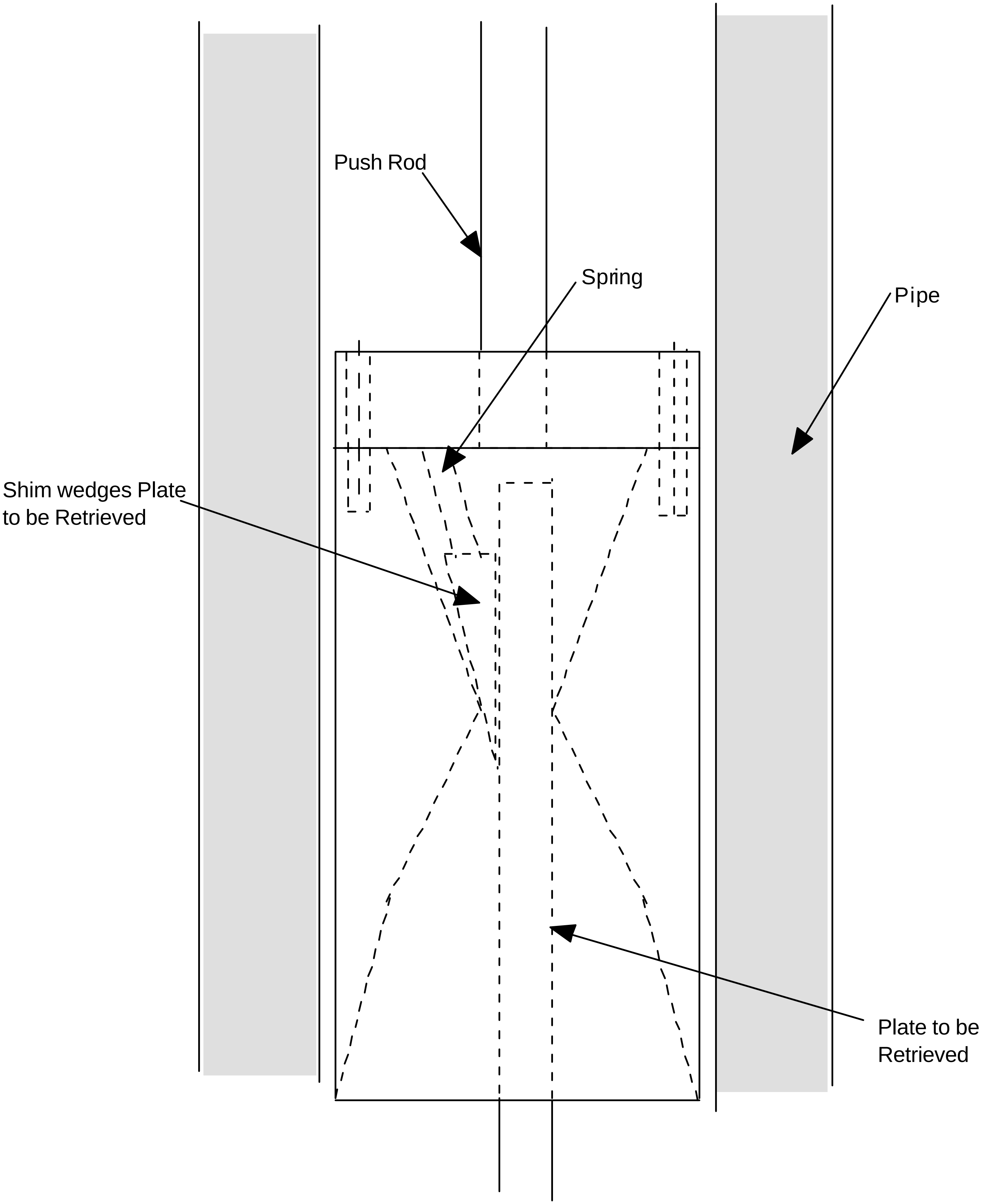

Figure 5: Wedge Retrieval Device Cross Section

Figure 6: Wedge Retrieval Device With Captured Item

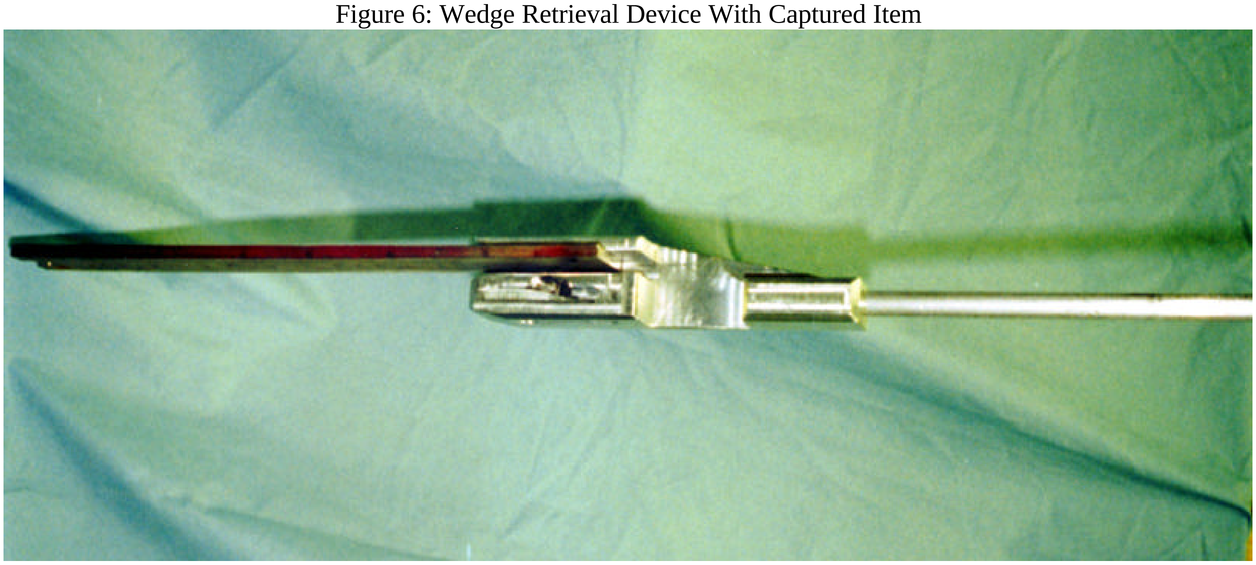
Figure 7: Wedge Wheel Retrieval Device

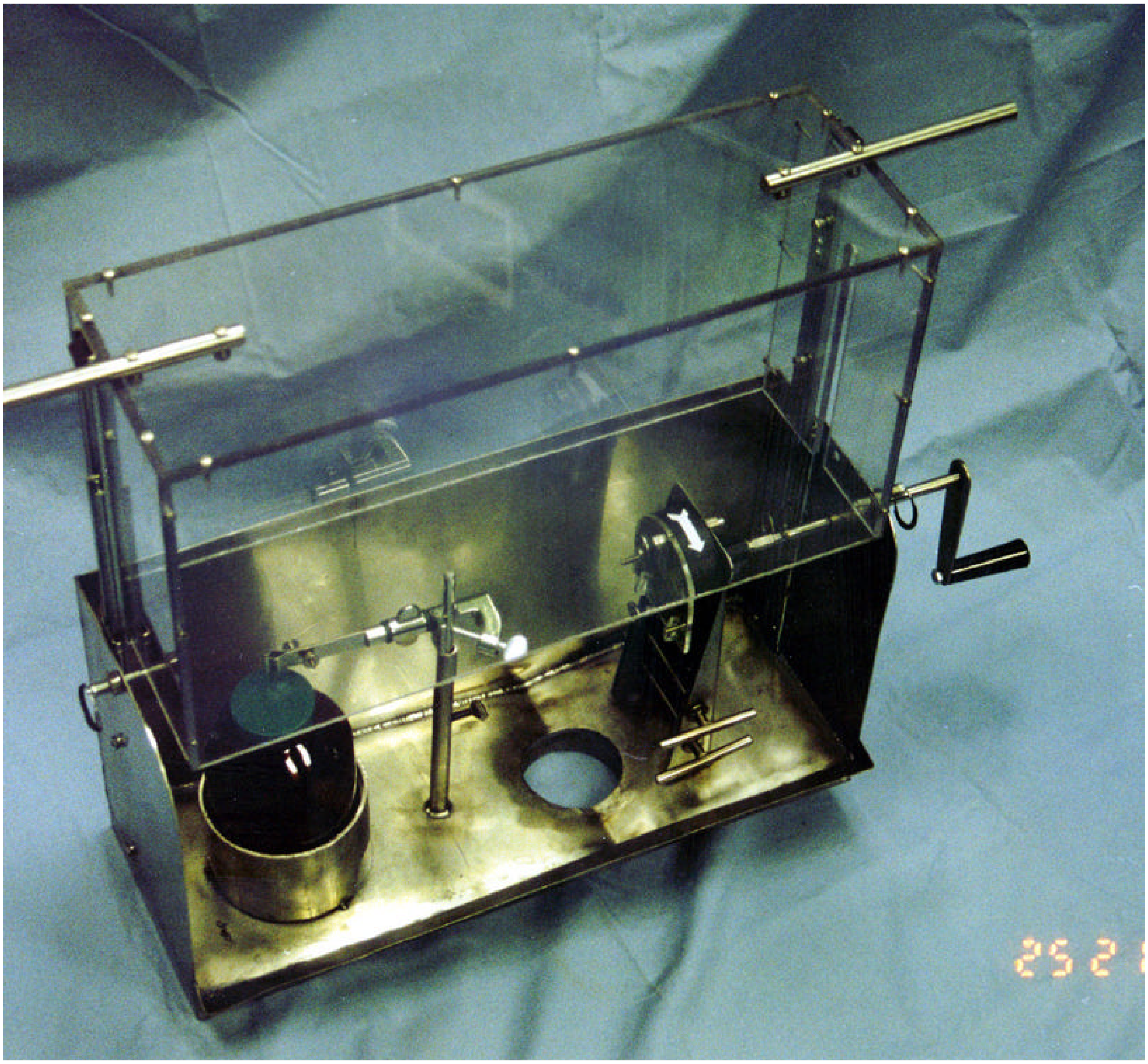

Figure 8: Solvent Sampling Device

Figure 9: Sludge Sampling Device